ARSD College, University of Delhi

Lesson Plan

Course Name : B.Sc. (H) Mathematics						
Semester	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Credit (C)**
VI	BMATH614	Ring Theory and Linear Algebra-II	5	1		
Teacher/Instructor(s)		Mr. AGAM DWIVEDI				
Session		2022-23				

Course Objective: This course introduces the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers, used in finite fields with applications in Cryptography. This course emphasizes the application of techniques using the adjoint of a linear operator and their properties to least squares approximation and minimal solutions to systems of linear equations.

Course Learning Outcomes: On completion of this course, the student will be able to:

i) Appreciate the significance of unique factorization in rings and integral domains.

ii) Compute with the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.

iii) Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain orthonormal basis.

Lesson Plan:

Unit No.	Learning Objective	Lecture No.	Topics to be covered
1.	Polynomial rings	1-5	Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains.
2.	Factorization of polynomials and Reducibility	6-15	Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein's criterion, Unique factorization in Z[x].
3.	Divisibility in integral domains	16-25	Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.
4.	Dual spaces	26-30	Dual spaces, Double dual, Dual basis, Transpose of a linear transformation and its matrix in the dual basis, Annihilators.
5.	Eigenvalues and Eigenvectors	31-40	Eigenvalues, Eigenvectors, Eigenspaces and characteristic polynomial of a linear operator; Diagonalizability, Invariant subspaces and Cayley-Hamilton theorem; The minimal polynomial for a linear operator
6.	Inner product space	41-45	Inner product spaces and norms
7.	orthogonalization	46-55	Orthonormal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality.
8.	adjoint of a linear operator	56-60	The adjoint of a linear operator and its properties, Least squares approximation, Minimal solutions to systems of linear equations

9.	Normal, Self-adjoint, unitary and orthogonal operators	61-70	Normal, Self-adjoint, unitary and orthogonal operators and their properties

Evaluation Scheme:

No.	Component	Duration	Marks
1.	Internal Assessment		25
	Quiz		
	Class Test		
	Attendance		
	Assignment		
2.	End Semester Examination	3 hr	75

Details of the Course		
Unit	**Contents**	**Contact Hours**
1	Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains.	05
2	Factorization of polynomials, Reducibility tests, Irreducibility tests, Eisenstein's criterion, Unique factorization in Z[x].	10
3	Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.	10
4	Dual spaces, Double dual, Dual basis, Transpose of a linear transformation and its matrix in the dual basis, Annihilators.	05
5.	Eigenvalues, Eigenvectors, Eigenspaces and characteristic polynomial of a linear operator; Diagonalizability, Invariant subspaces and Cayley-Hamilton theorem; The minimal polynomial for a linear operator.	10
6.	Inner product spaces and norms.	05
7.	Orthonormal basis, Gram-Schmidt orthogonalization process, Orthogonal complements, Bessel's inequality.	10
8.	The adjoint of a linear operator and its properties, Least squares approximation, Minimal solutions to systems of linear equations	05
9.	Normal, Self-adjoint, unitary and orthogonal operators and their properties.	10
	Total	**70**

Suggested Books:

Sl. No.	**Name of Authors/Books/Publishers**	**Year of Publication/Reprint**
1	Friedberg, Stephen H., Insel, Arnold J., & Spence, Lawrence E. (2003). Linear Algebra (4th ed.). Prentice-Hall of India Pvt. Ltd. New Delhi.	2003
2	Gallian, Joseph. A. (2013). Contemporary Abstract Algebra (8th ed.). Cengage Learning India Private Limited. Delhi. Fourth impression, 2015.	2015
3	Herstein, I. N. (2006). Topics in Algebra (2nd ed.). Wiley Student Edition. India	2006
4.	Hoffman, Kenneth, & Kunze, Ray Alden (1978). Linear Algebra (2nd ed.). Prentice-Hall of India Pvt. Limited. Delhi. Pearson Education India Reprint, 2015.	2015

Mode of Evaluation:	Internal Assessment / End Semester Exam

Mr. AGAM DWIVEDI
Assistant Professor
Department of Mathematics